Space Weather Technical Forecast

Issued on Sunday, 16 April 2023 at 12:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts), slight chance of X-Class flares (R3 strong radio blackouts) throughout. Slight chance of G1/Minor Storms on 19 Apr due to possible CMEs.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the past 24 hours, with only C-class flare activity from a number of different regions. AR3279, and AR3281 and AR3282 are all in the eastern hemisphere and are responsible for some of the more energetic C-class flares. AR3279 appears to have strengthened slightly after earlier weakening, with AR3281 in contrast appearing to weaken in appearance. AR3282 in the northeast has stabilised after previous developments, with AR3280 in the southwest also stabilising. These four regions are the most magnetically complex and largest of the 11 regions on the visible disc. The remaining regions are all either weak, declining or stable.

Three notable eruptions have been analysed for potential Earth impacts. A large filament liftoff observed in the northern hemisphere approximately 15/1100UTC has been analysed and may glance the earth on 19 Apr. A filament eruption from the southwest at 15/2250UTC was assessed at moving at around 900km/s, but appears to be passing by the Earth. A near full halo eruption, as the result of a filament liftoff on in the northwest at 15/2330UTC is currently being analysed, but the location and imagery suggest a potential Earth arrival on 19 Apr, based on speeds of 325-375km/s.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 has generally been slow at below 400km/s throughout with density also below average. Total magnetic field strength, IMF, was weak, with the north-south component, Bz, also varying weakly. Phi angle was predominantly positive (away from the Sun), with brief fluctuations into the negative sector. Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at background levels. High energy electron flux (greater than 2MeV) as measured at GOES16 was at background levels. The associated 24-hour integrated electron fluence was well below the Active threshold on a slightly declining trend, falling to 1.28e6 integrated pfu observed at 16/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be mainly Low, with a likelihood of Moderate activity through the next four days. There is a slight chance of X-class flare activity.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 12 Apr was due to arrive early on 16 Apr, with decreasing confidence in a potential arrival. Two CMEs observed during 15 Apr have been analysed with one from the northwest potentially glancing the Earth on 19 Apr. A near full halo has been analysed and although results are awaited, the potential speed of the CME suggests an arrival on 19 Apr. No coronal hole high speed streams are forecast to connect, with the fast winds from coronal holes 92 and 93 expected to have missed the Earth. Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a current slight chance of G1/Minor Storm intervals on 19 Apr.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels, although there is a slight chance of a greater than S1 event as some of the more complex active regions transit towards the western solar hemisphere. High energy (greater than 2 MeV) electron flux is currently at background levels throughout the period. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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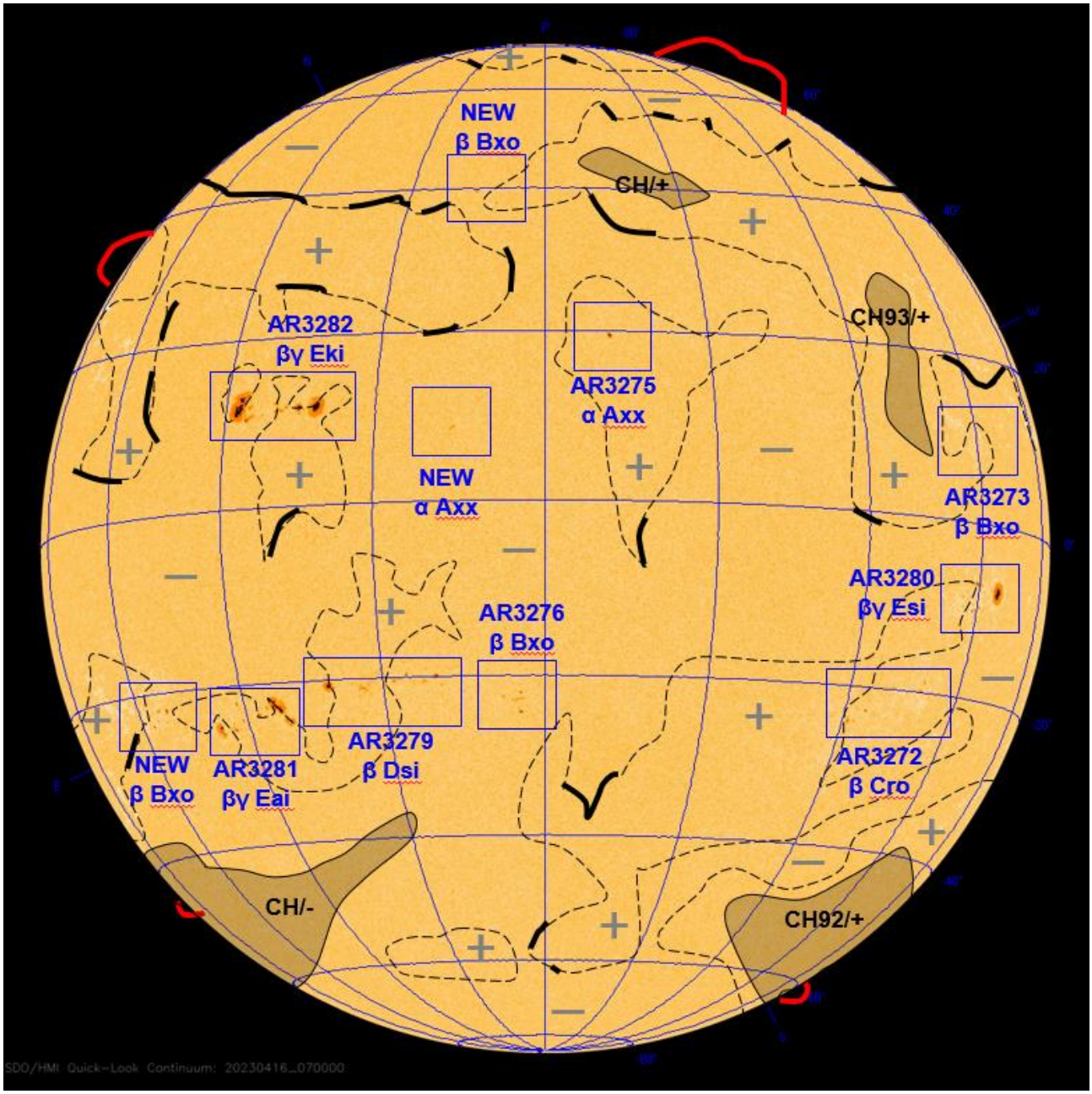
Figure 1. Solar Analysis Valid 16/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on 12 April was due to glance the Earth early on 16 Apr, but no arrival has been observed and this continues to be monitored. Three potentially significant eruptions occurred on 15 Apr. A partial halo from a filament eruption from the northwest at 15/1120UTC has been modelled and may glance the Earth on 19 Apr. A filament eruption from the southwest at 15/2250UTC appears to be directed away from Earth. The third eruption, a long period filament eruption from the northwest around 15/2330UTC is potentially a full halo with an analysed speed of 325-375km/s, although STEREO A imagery was not initially available for this analysis. A preliminary analysis has been submitted to the MOSWOC Enlil model with a likelihood of an Earth-directed component, with an estimated arrival on 19 Apr.

The high speed streams from coronal holes 92 and 93 were forecast to potentially connect with the Earth on 15 April, but the near-earth environment appears benign, with the high speed stream likely to be passing to the north or south of the Earth. No further coronal holes are forecast to connect with the Earth in the forecast period.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a slight chance for potential CME arrival on 16 Apr. There is a risk of Active or G1/Minor Storm intervals from a partial halo CME from the northwest and a slow near full halo CME, both of which may arrive either later on 19 Apr.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	1	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0550	Partial halo	Filament	NW quadrant	200km/s	19/1200UTC	Low confidence. Limited impacts expected.
16/1343	Near full halo	Filament	NW quadrant	325-375km/s	19 Apr	Awaiting results in Enlil

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Figure 2: Enlil ensemble data for the next four days. The peak on 16 Apr was the CME anticipated to arrive from an eruption on 12 Apr. The peak on 19 Apr is from the 15/1100UTC partial halo. Results are being processed for the 15/2330UTC eruption, with a possible arrival on 19 Apr.

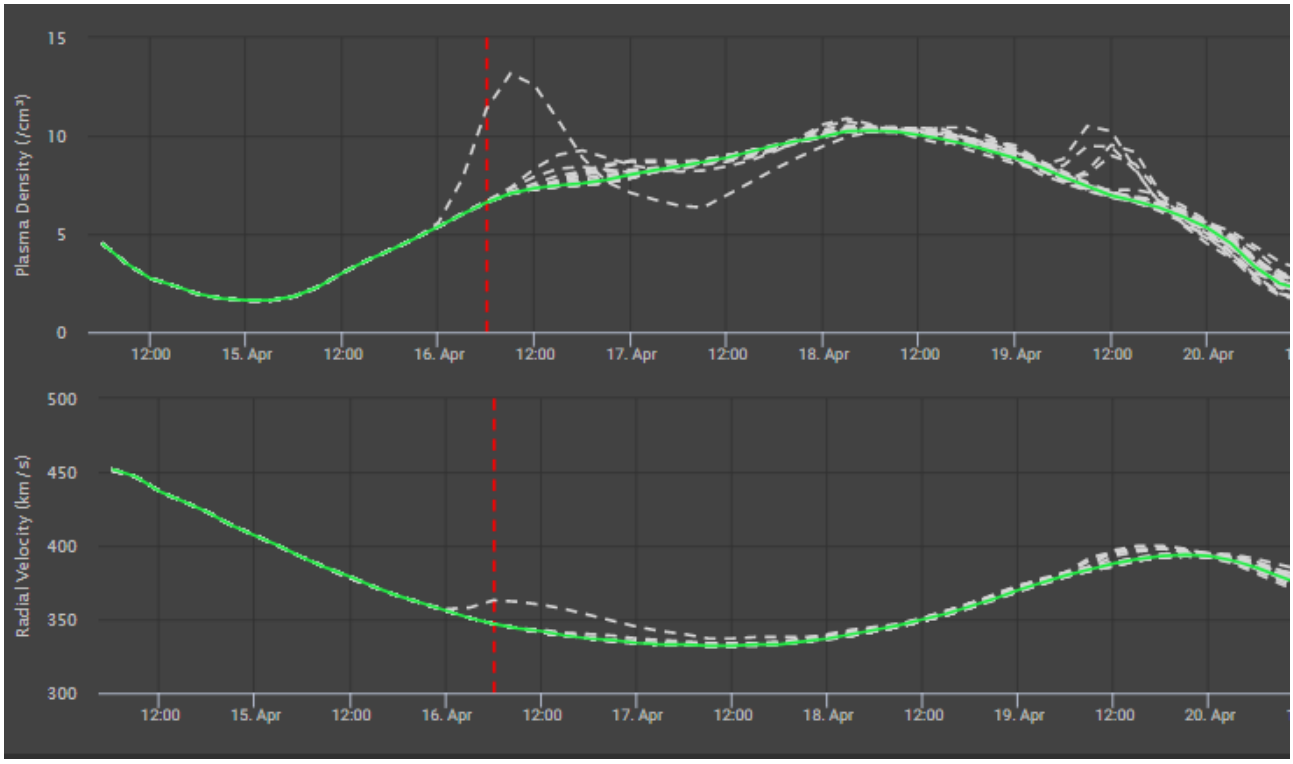
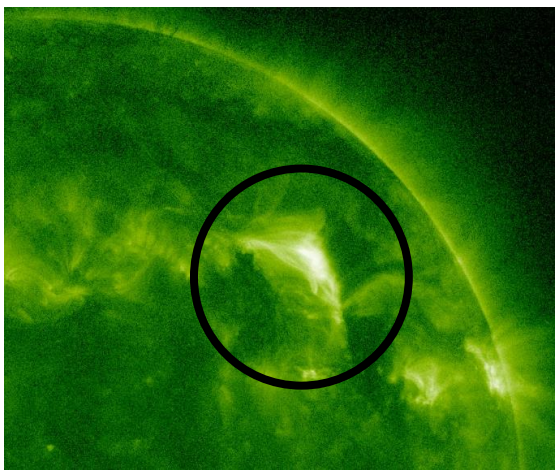
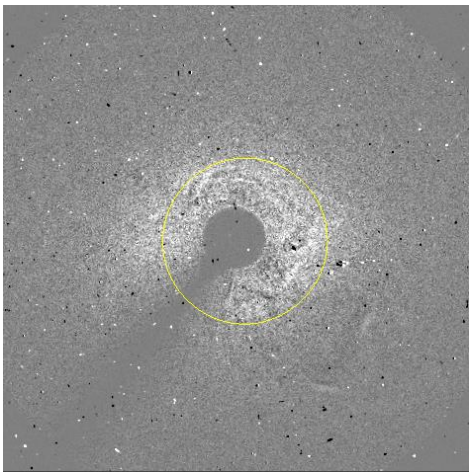


Figure 3: SDO/AIA 94 imagery at 15/2330UTC of the filament lift off resulting in the full halo. The image on the right is a greyscale image of SOHO LASCO C3 imagery, with the near full halo outlined.





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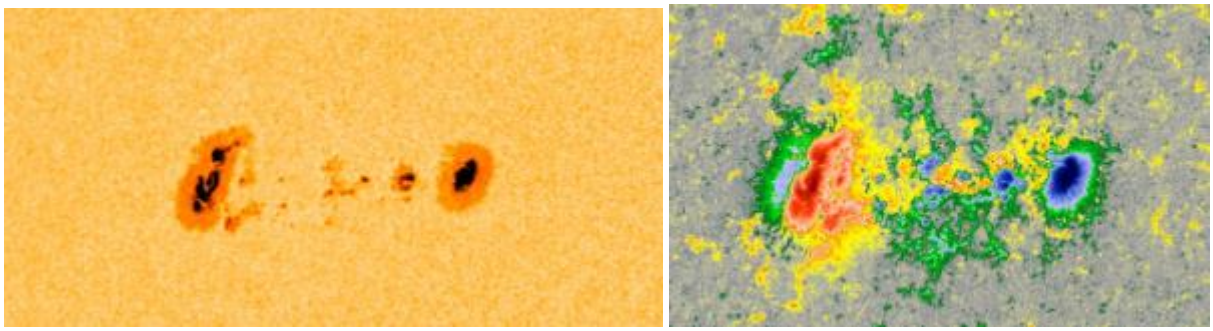
Radio Blackouts - X-Ray Flares:
There are 11 active regions on the visible disc with AR3282 and AR3282 potentially the most prominent and highest risk regions on the disc. AR3279 has developed slightly after previous fading, with AR3281 to the southeast, showing some weakening. The previously large region AR3272 continues to fade and weaken. The remaining regions are also weak and stable, or evolving very slowly.

Mainly Low to Moderate solar activity is forecast through the next four days based on the current sunspot configurations. There is a potential for two notable regions to rotate from the far side based on analysis of helioseismology and SDO imagery. Further analysis of these regions will take place as they rotate onto the visible disc. Based on the complexity of the large sunspot groups, there is also a slight chance of X-class flaring.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: AR3282 (Eki/βγ) in both intensitygram and magnetogram imagery



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at background levels through the period.

AR3280 carries the greatest risk of a proton event early in the period, with a continued high level of magnetic complexity as it rotates across the western hemisphere. A number of regions in the east could produce some proton response from particularly energetic events, with these acting to maintain the risk into the period as they rotate westward.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater then 2MeV) is at background levels and is likely to remain muted in a benign solar wind environment with no significant high speed stream effects expected. The British Antarctic Survey Radiation Belt Model (BAS-RBM) is forecasting a similarly muted environment, with good verification from the last four days. Any inputs from CME effects may have a neutral effect in the short term, considering the balance between an increase in any geomagnetic activity and input of material into the radiation belts.

The associated electron fluence forecast is well below the Active (1e8 integrated pfu) threshold and is expected to remain so during the forecast period. MOSWOC REFM is forecasting a slightly rising trend in fluence for the next four days, viewed as good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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